FIG. 1

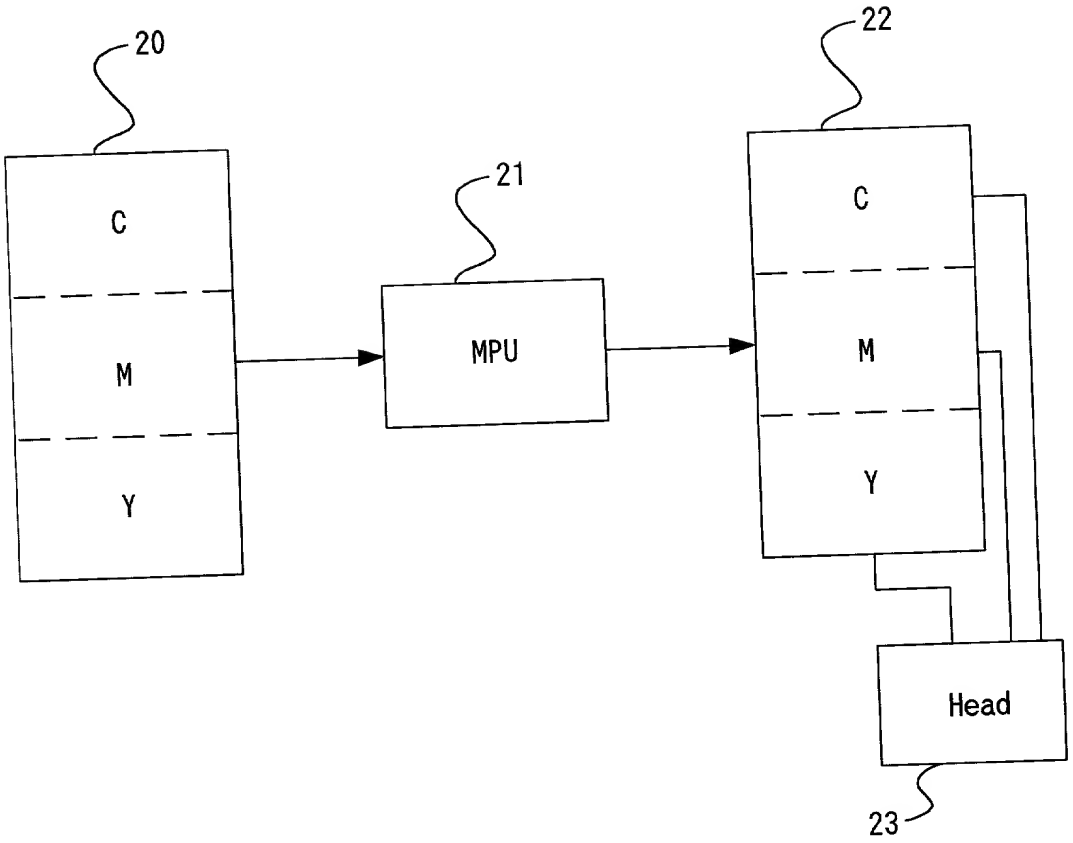


FIG. 2

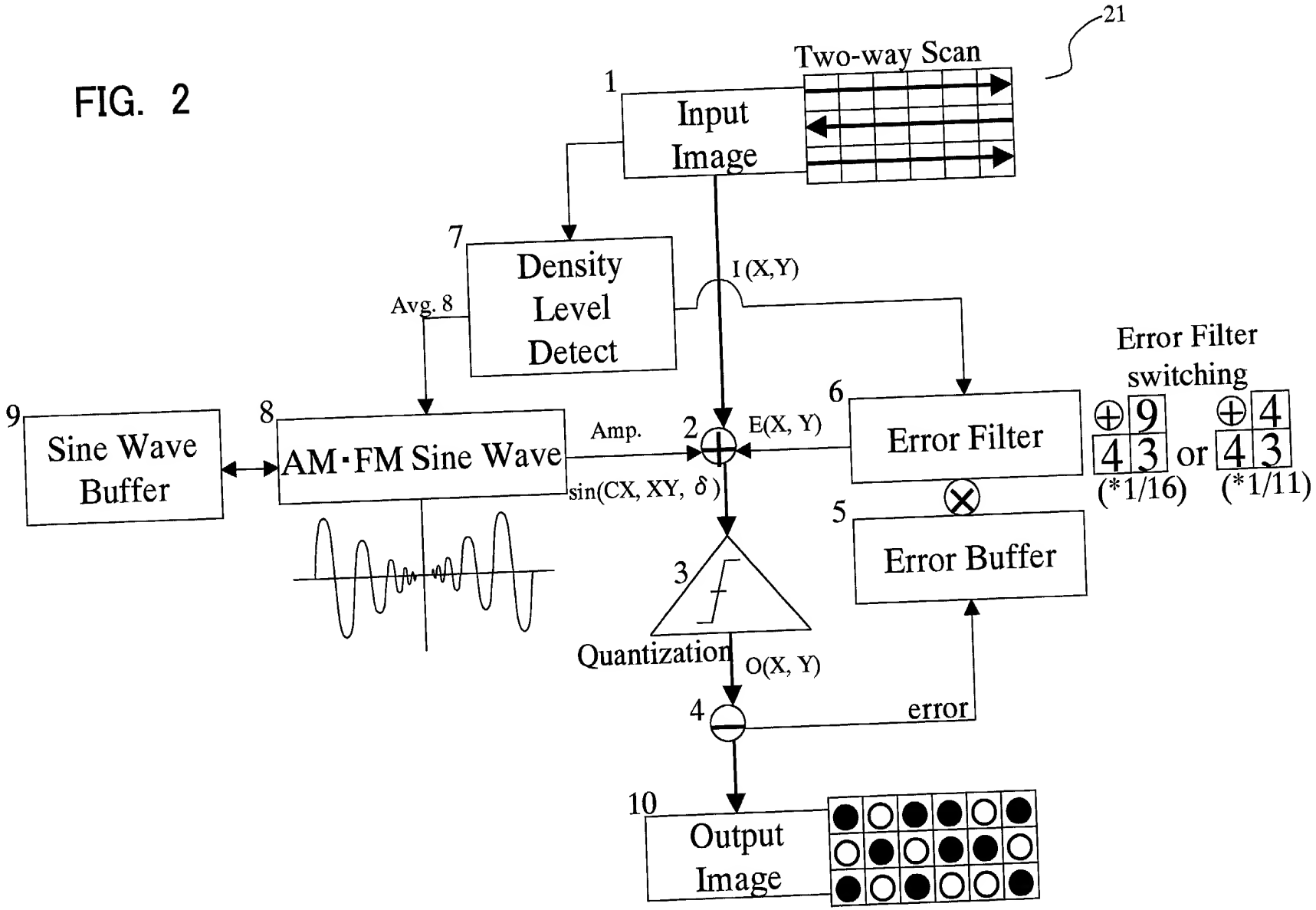

21
Two-way Scan
1
Input Image
7
Density Level Detect
Avg. 8
I(X,Y)
Error Filter switching
6
Error Filter
⊕ 9 / 4 3 (*1/16) or ⊕ 4 / 4 3 (*1/11)
9
Sine Wave Buffer
8
AM·FM Sine Wave
Amp.
2
E(X, Y)
sin(CX, XY, δ)
5
Error Buffer
3
Quantization
O(X, Y)
4
error
10
Output Image

FIG. 3

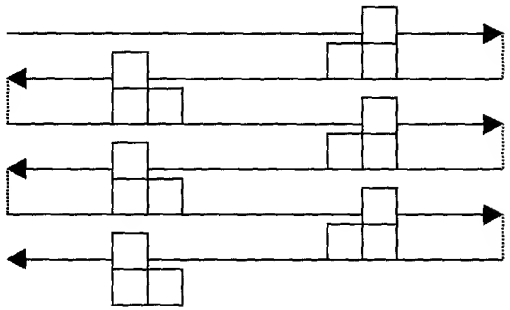


FIG. 4

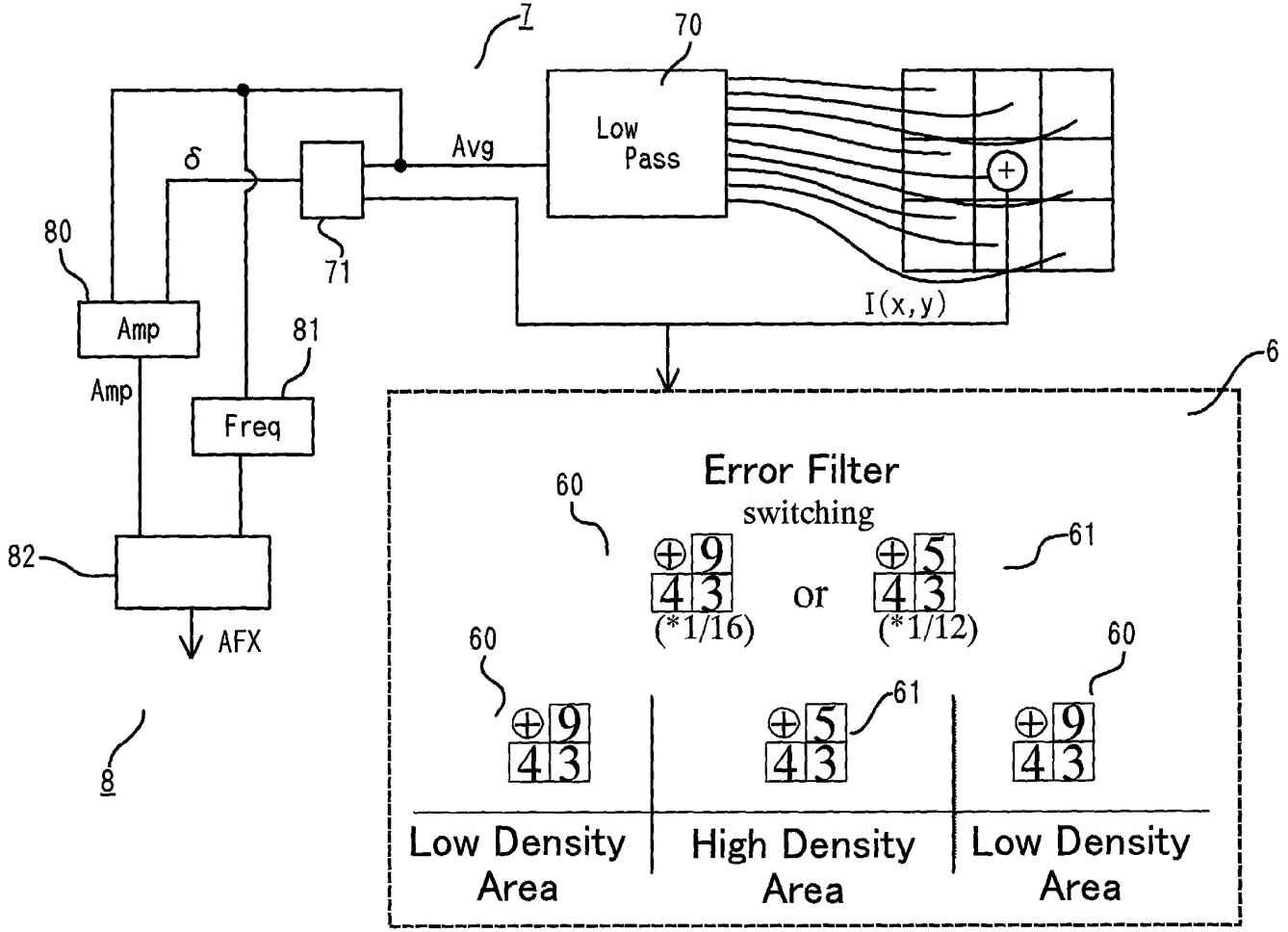

7
70
Low
Pass
Avg
δ
71
80
Amp
Amp
81
Freq
82
AFX
8
I(x,y)
6
Error Filter
switching
60
61
or
(*1/16)
(*1/12)
Low Density
Area
High Density
Area
Low Density
Area

FIG. 5A

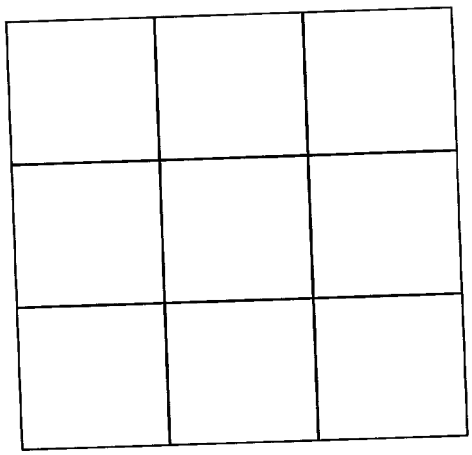


FIG. 5B

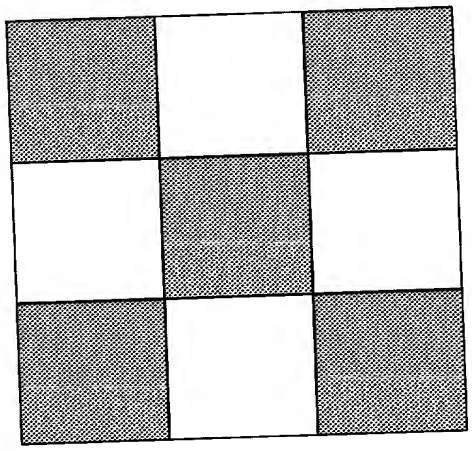


FIG. 5C

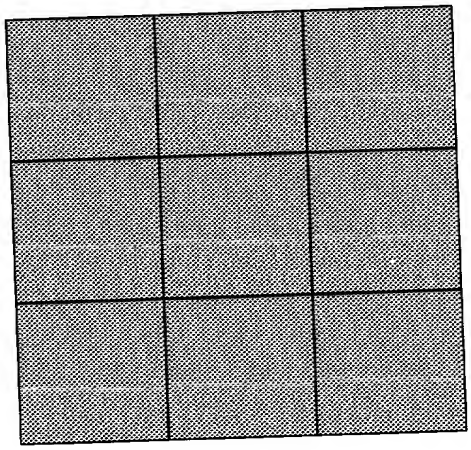


FIG. 6A

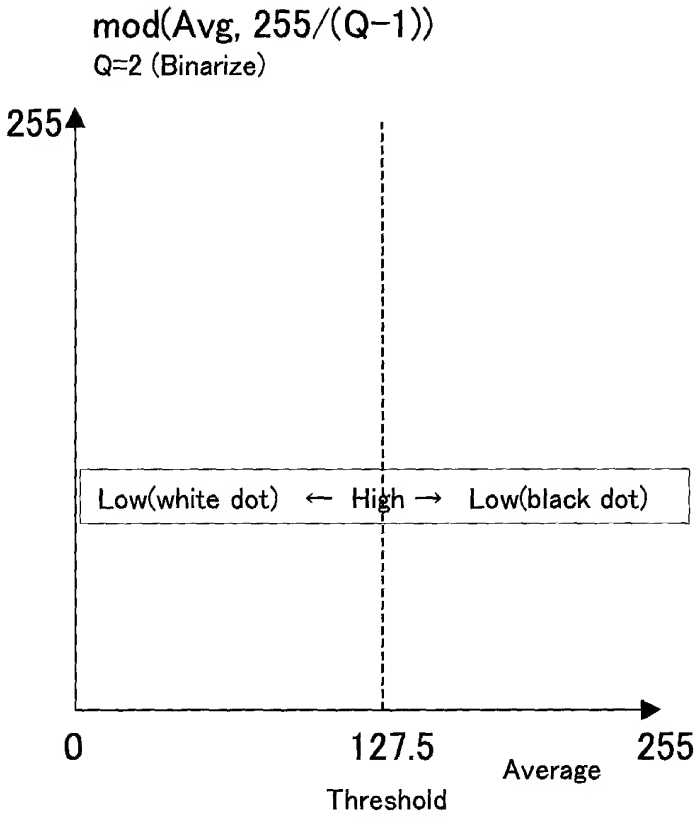

mod(Avg, 255/(Q-1))
Q=2 (Binarize)
255
Low(white dot) ← High → Low(black dot)
0
127.5
Threshold
Average
255

FIG. 6B

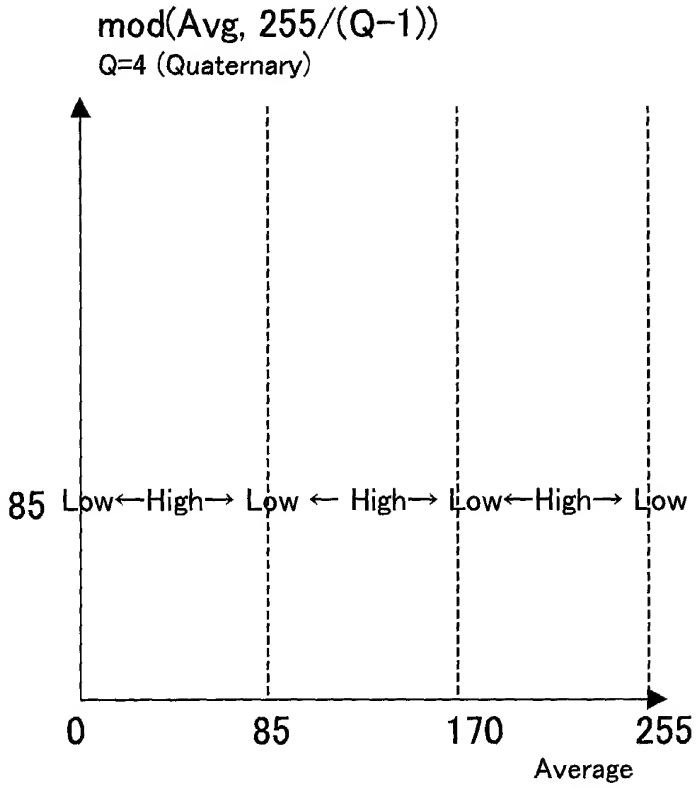

mod(Avg, 255/(Q-1))
Q=4 (Quaternary)
85 Low←High→ Low ← High→ Low←High→ Low
0
85
170
255
Average

FIG. 7A

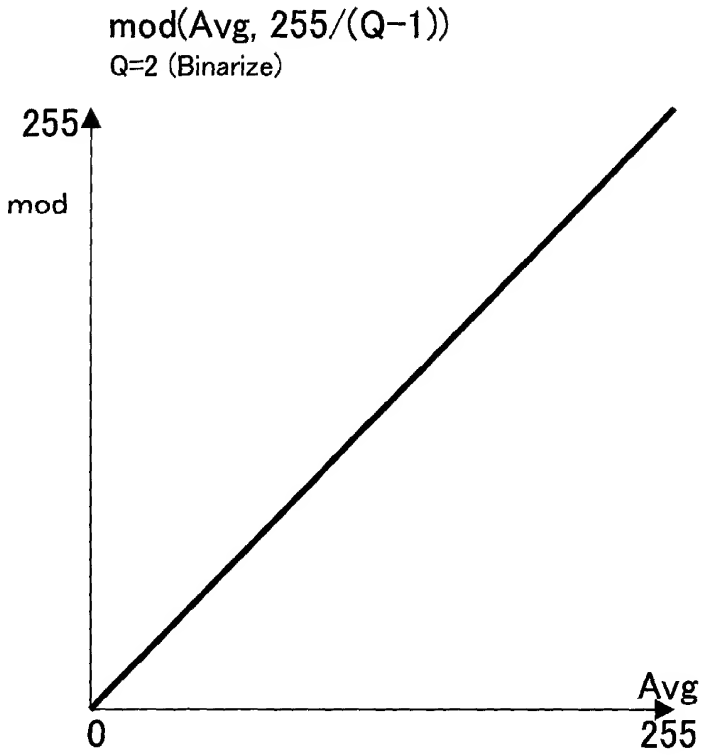

mod(Avg, 255/(Q-1))
Q=2 (Binarize)
255
mod
0
Avg
255

FIG. 7B

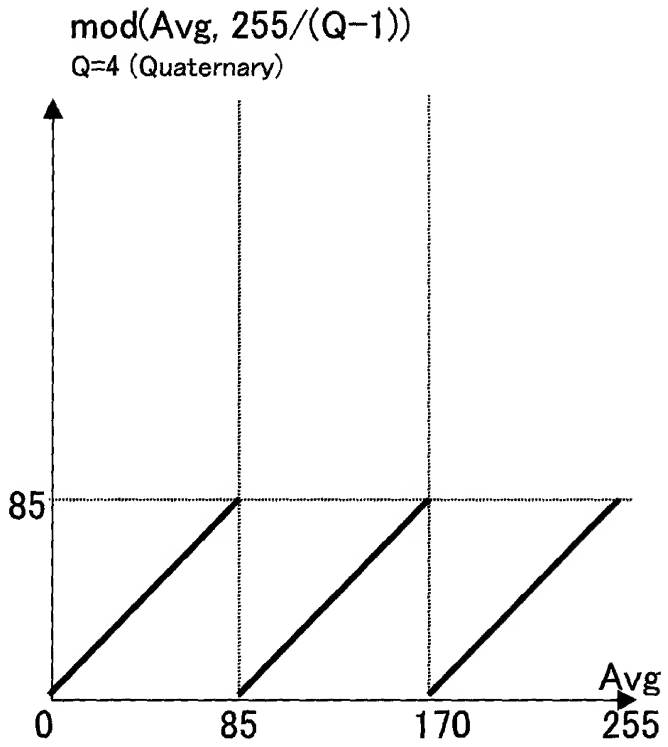

mod(Avg, 255/(Q-1))
Q=4 (Quaternary)
85
0
85
170
Avg
255

FIG. 8A

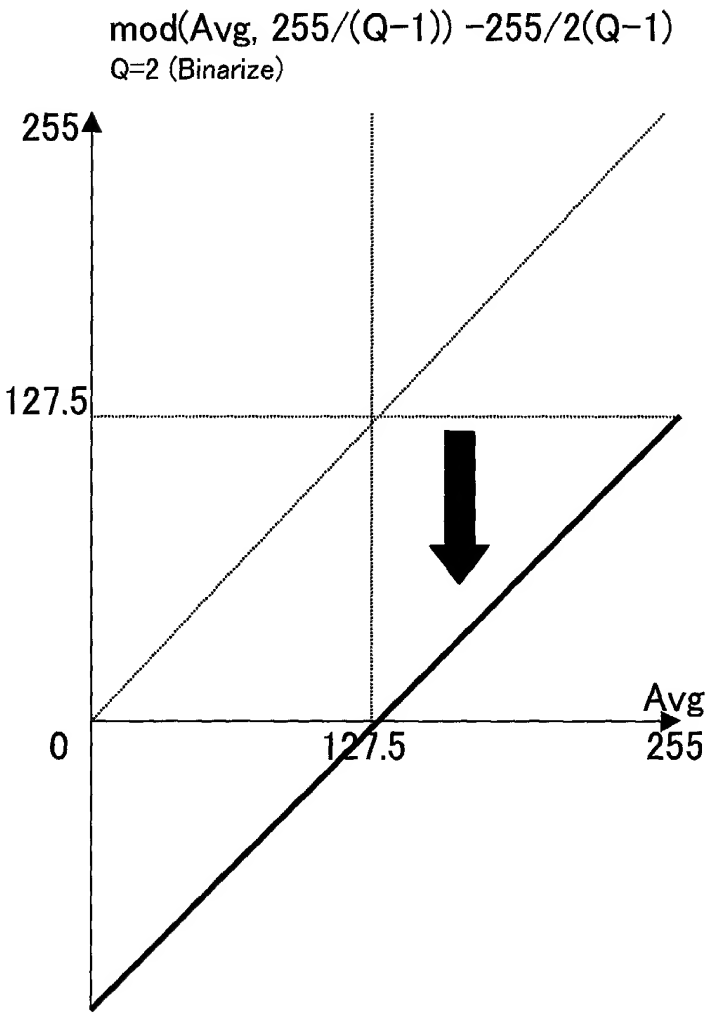

mod(Avg, 255/(Q-1)) -255/2(Q-1)
Q=2 (Binarize)
255
127.5
0
127.5
Avg
255

FIG. 8B

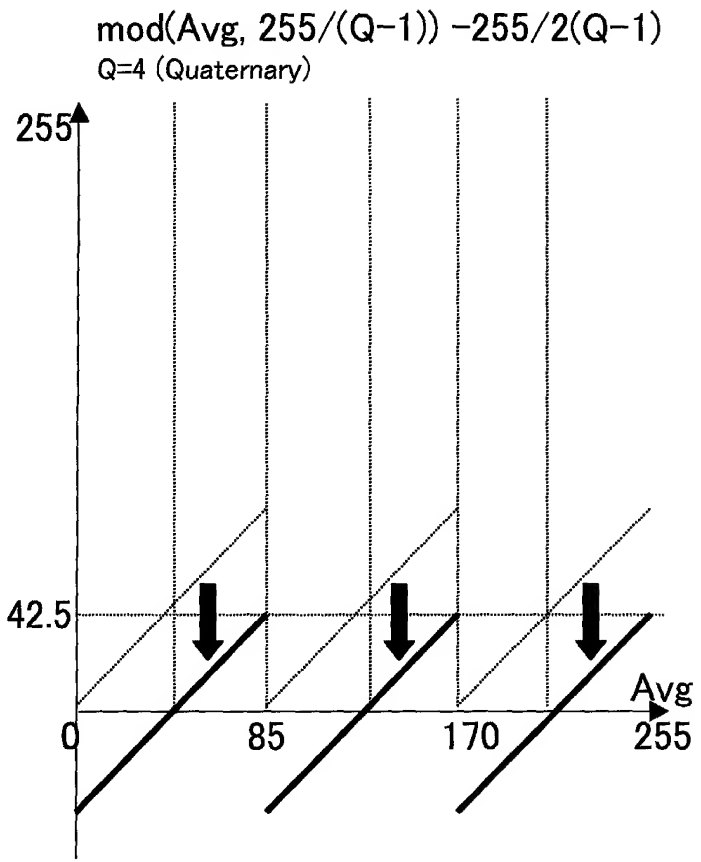

mod(Avg, 255/(Q-1)) -255/2(Q-1)
Q=4 (Quaternary)
255
42.5
0
85
170
Avg
255

FIG. 9A

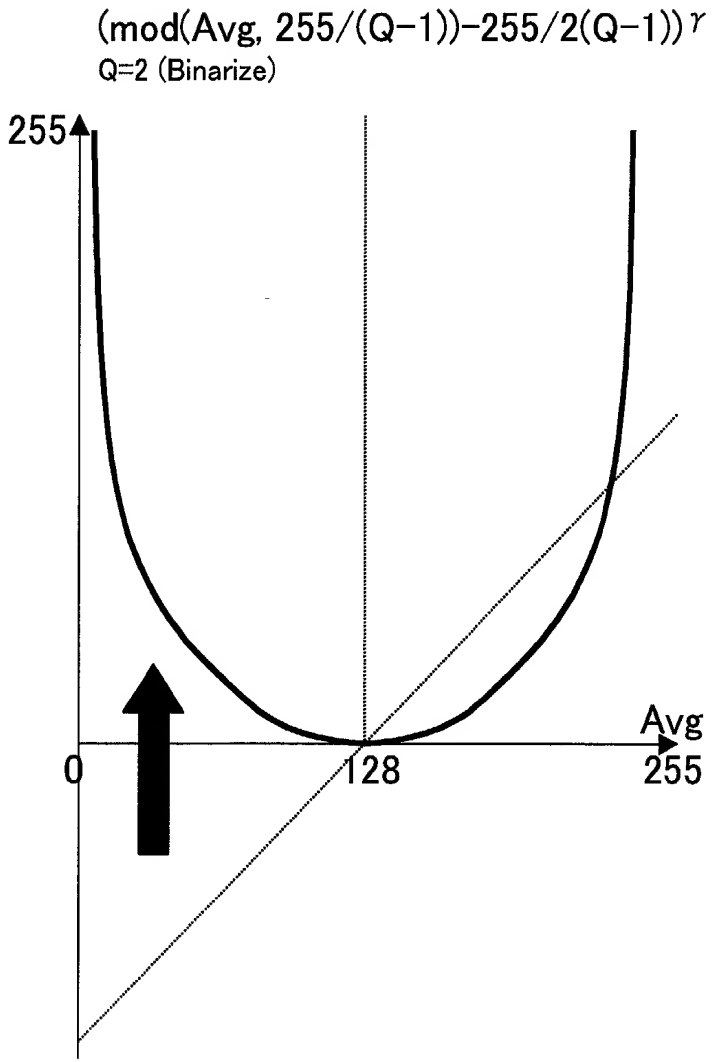

(mod(Avg, 255/(Q-1))-255/2(Q-1))γ
Q=2 (Binarize)
255
0
128
Avg
255

FIG. 9B

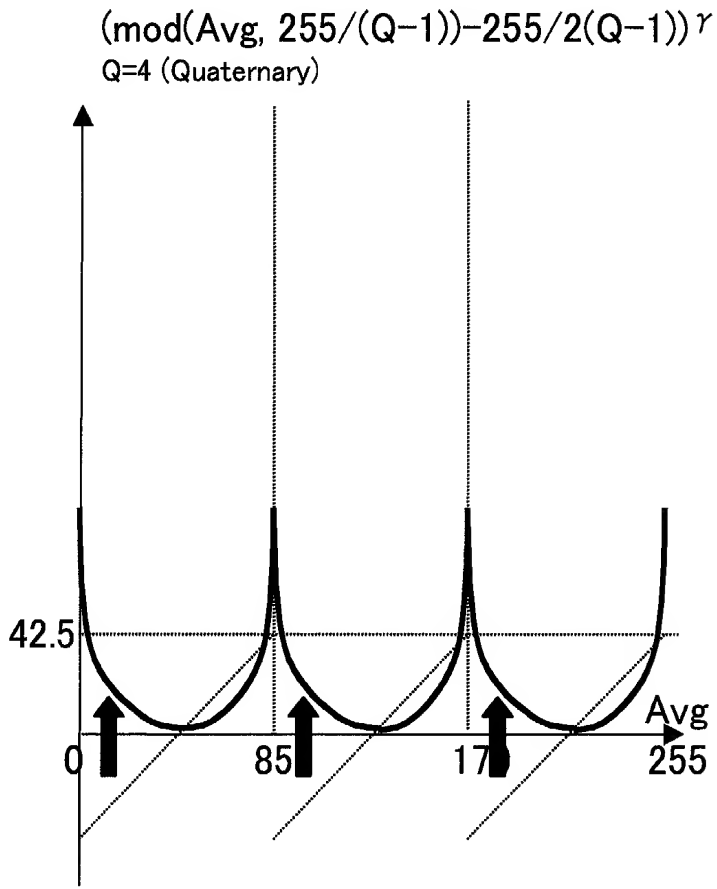
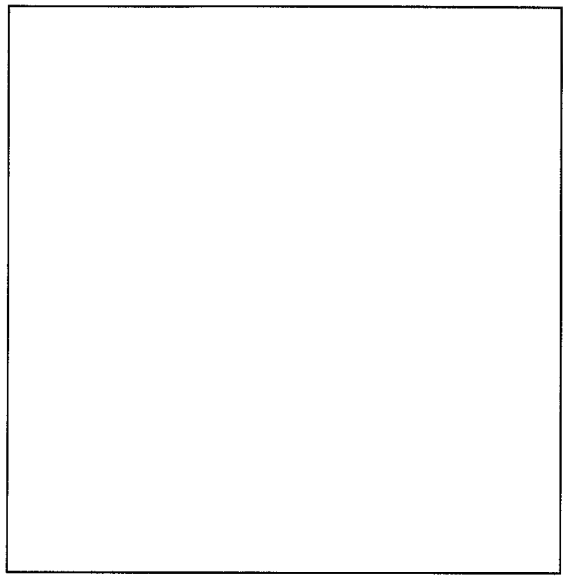
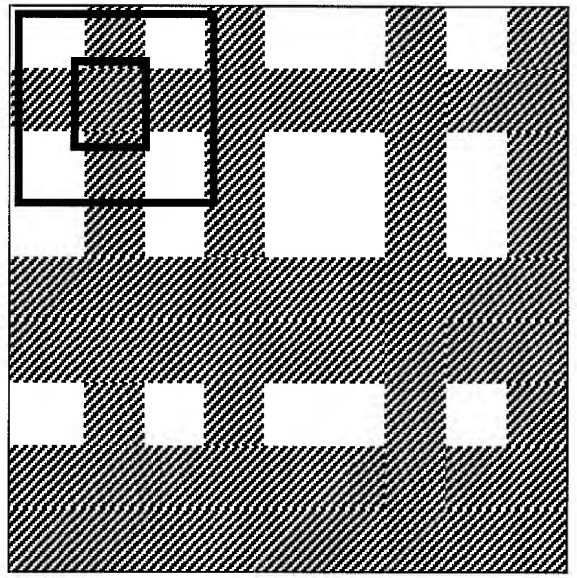

(mod(Avg, 255/(Q-1))-255/2(Q-1))γ
Q=4 (Quaternary)
42.5
0
85
17
Avg
255

FIG. 10



Low Density Variation
↓
Amp strongly functions,
as δ (difference) is small

δ :→



High Density Variation
↓
δ is large, Amp is small
↓
Prevent unclear edge by adding
AM-FM screen, thereby uniform dot
arrangement

FIG. 11

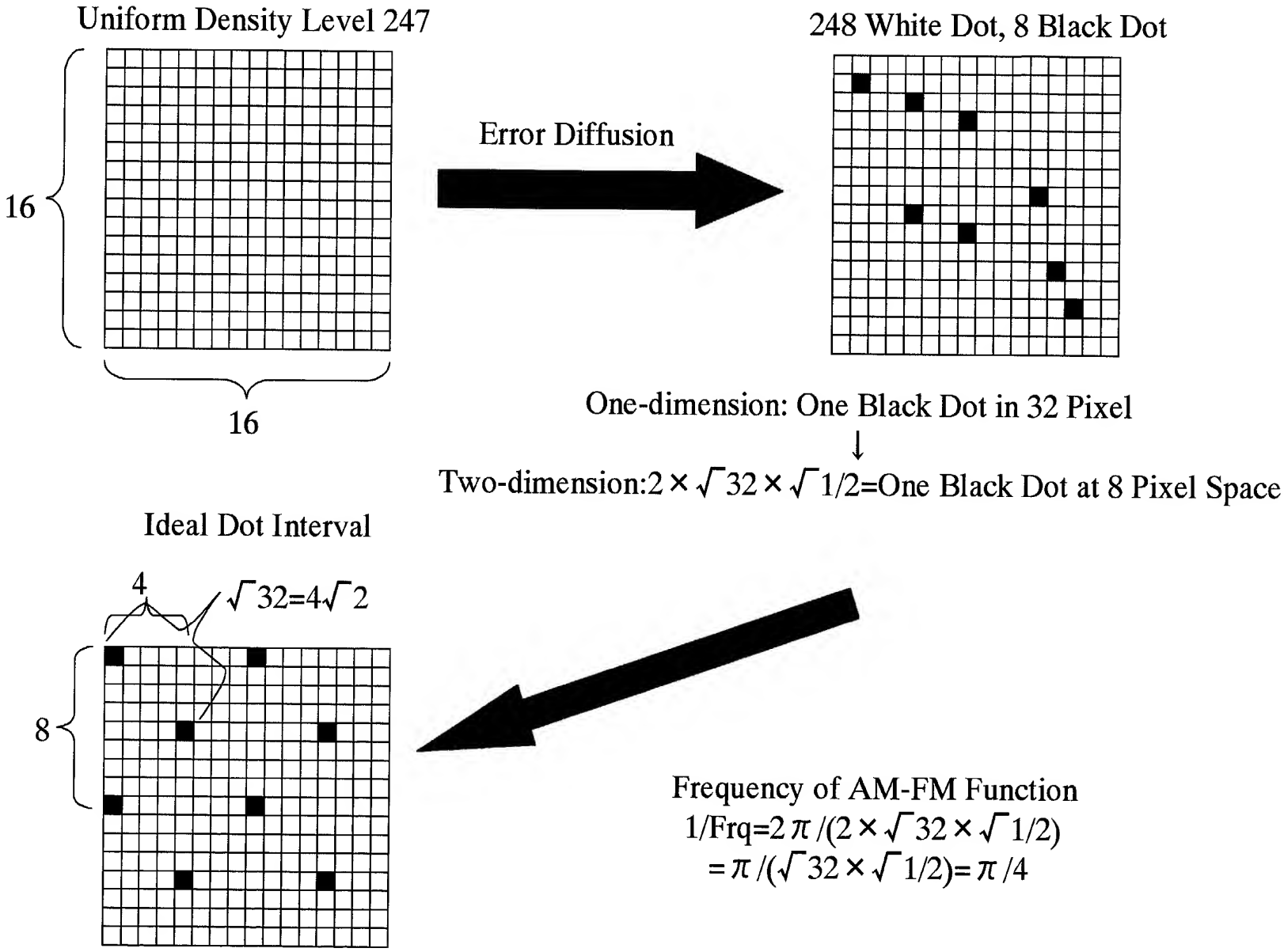
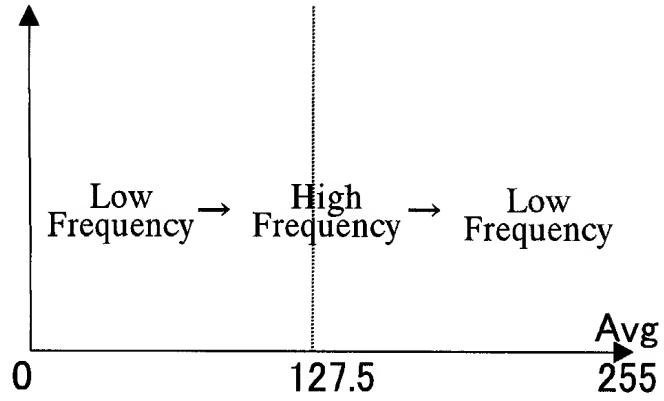

Uniform Density Level 247
16
16
Error Diffusion
248 White Dot, 8 Black Dot
One-dimension: One Black Dot in 32 Pixel
Two-dimension:2 × √32 × √1/2=One Black Dot at 8 Pixel Space
Ideal Dot Interval
4
√32=4√2
8
Frequency of AM-FM Function
1/Frq=2π/(2 × √32 × √1/2)
=π/(√32 × √1/2)=π/4

FIG. 12

Binarize
if Avg>=127.5
Frq=√(1/2)×√255/(255−Avg)/π
else
Frq=√(1/2)×√255/Avg/π



Quaternary
if mod(Avg, 85)−42.5>=0
Frq=√(1/2)·√[85/{85−mod(Avg, 85)}]/π
else
Frq=√(1/2·)√[85/mod(Avg, 85)]/π

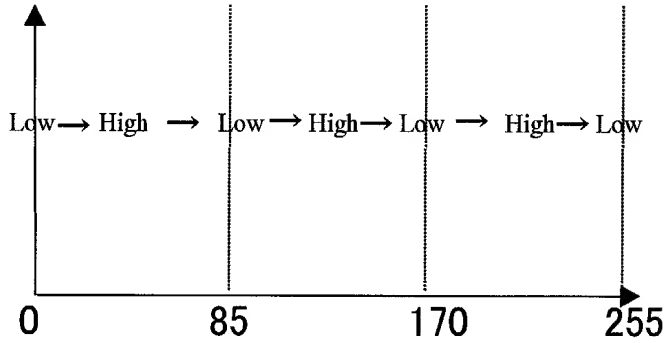


FIG. 13

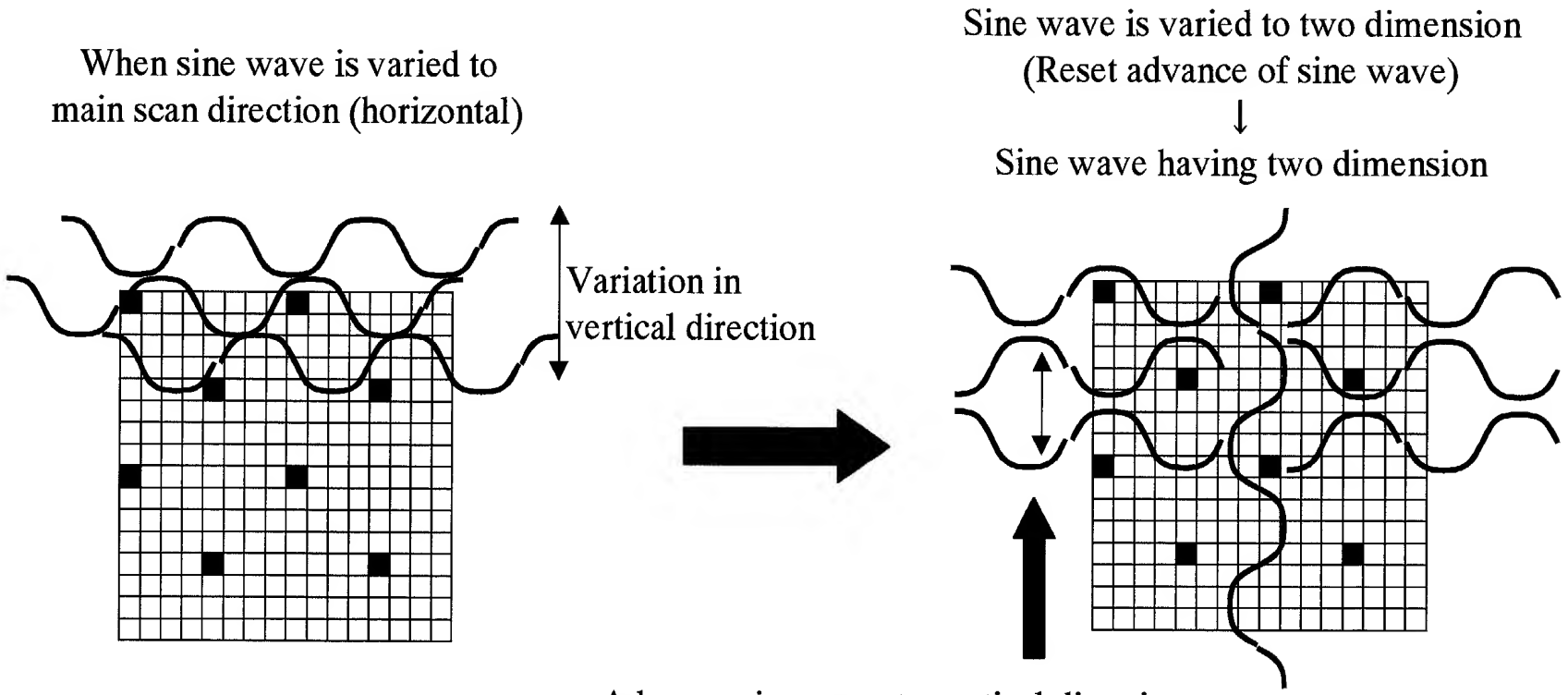

When sine wave is varied to
main scan direction (horizontal)
Variation in
vertical direction
Sine wave is varied to two dimension
(Reset advance of sine wave)
↓
Sine wave having two dimension
Advance sine wave to vertical direction
by referring stored cycle of AM-FM sine wave
at previous scan line

FIG. 14

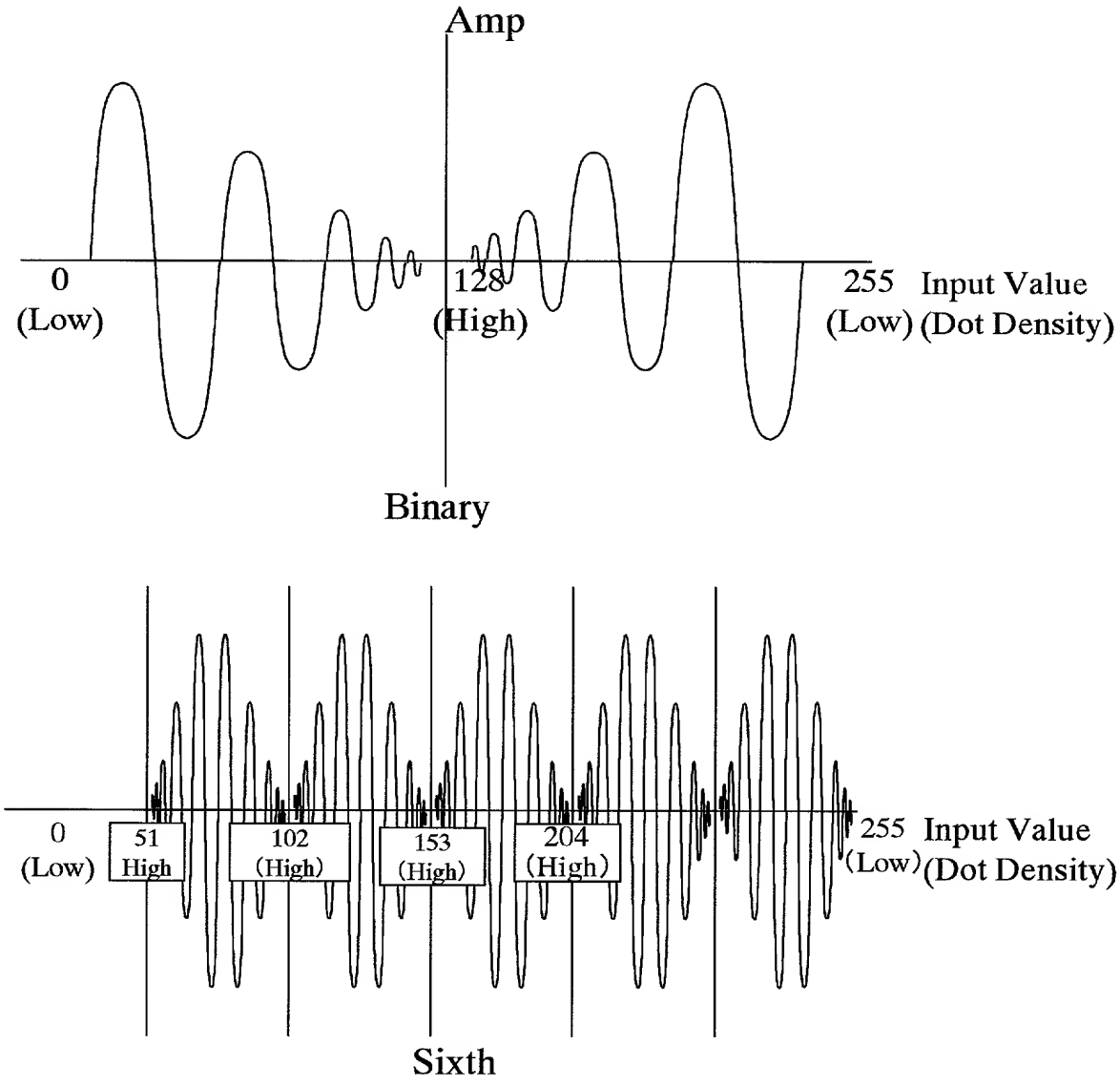

Amp
0
(Low)
128
(High)
255
(Low)
Input Value
(Dot Density)
Binary
0
(Low)
51
High
102
(High)
153
(High)
204
(High)
255
(Low)
Input Value
(Dot Density)
Sixth

FIG. 15

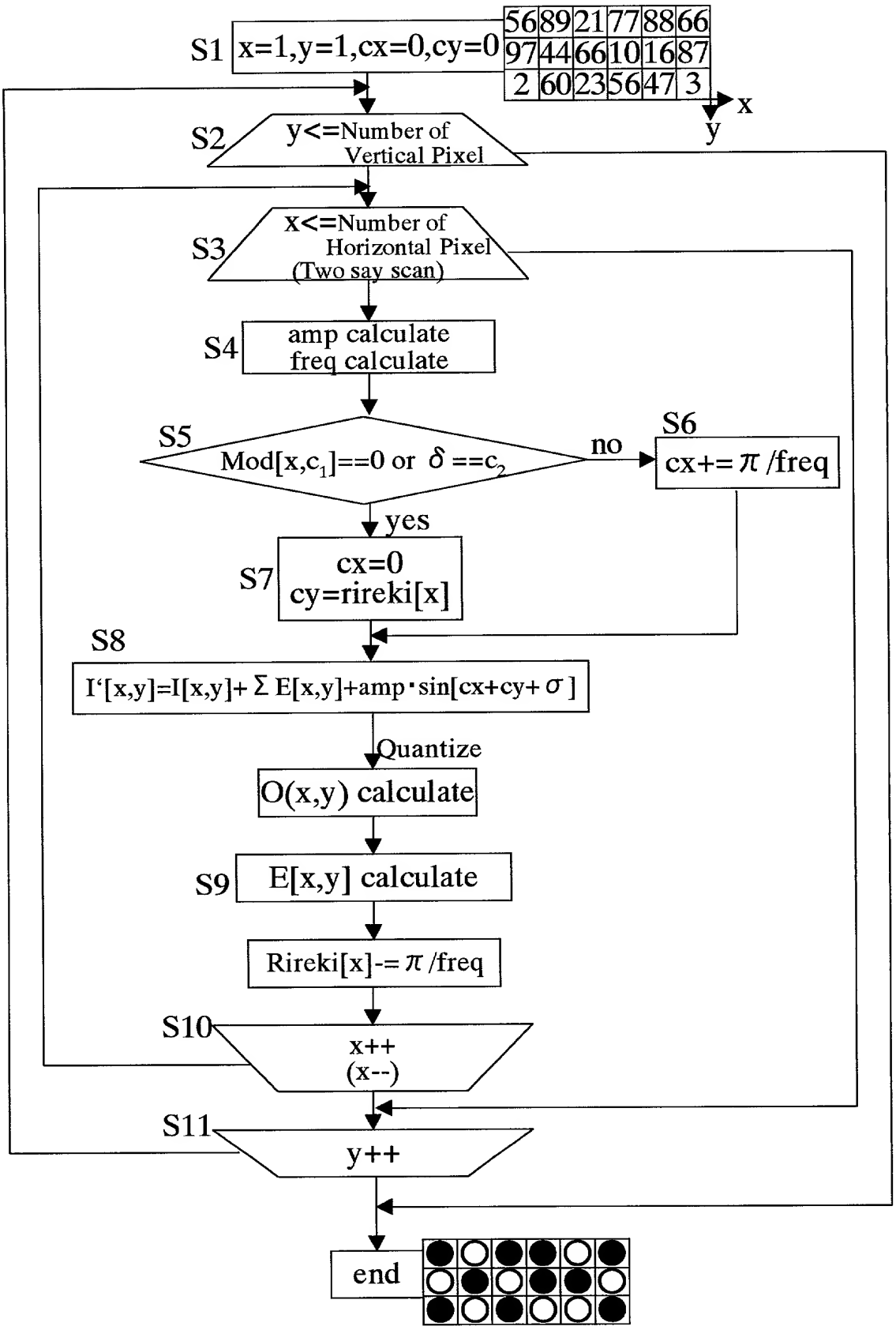
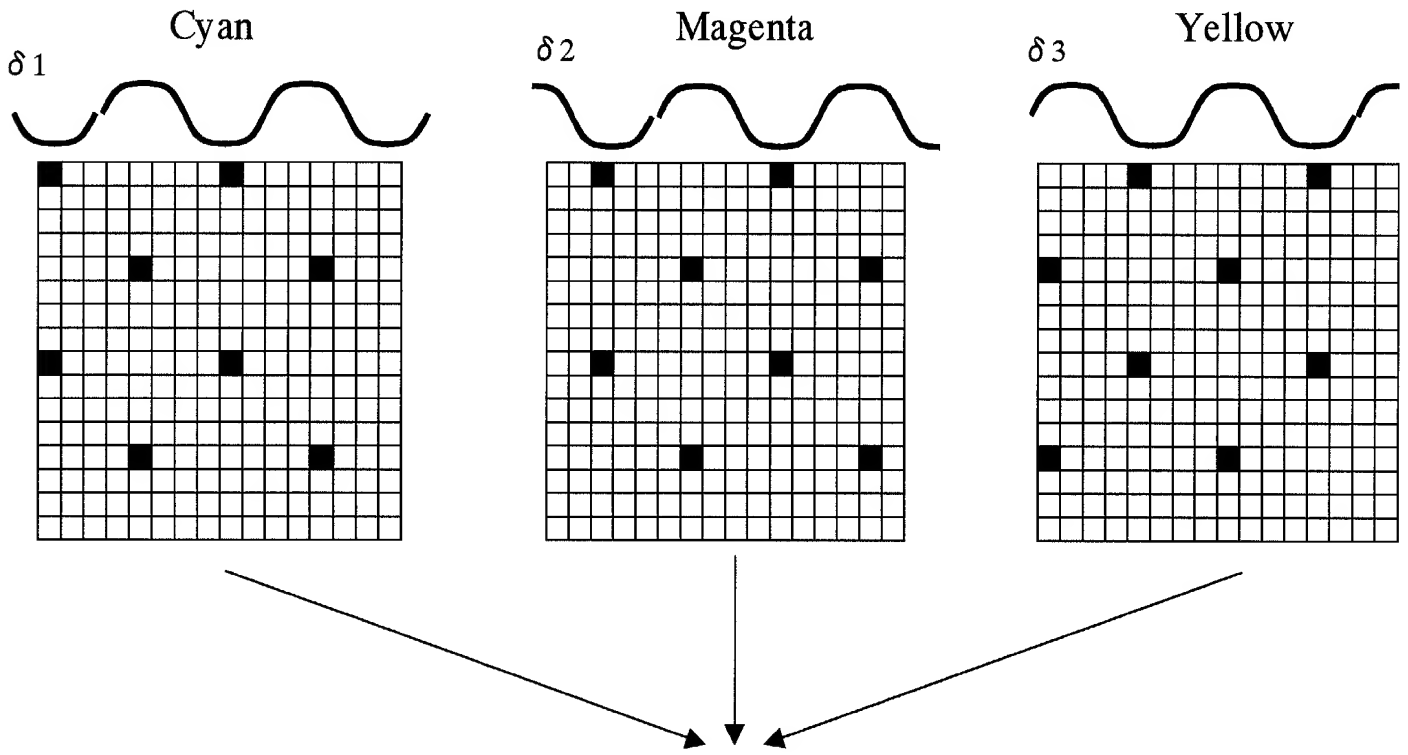

S1
x=1,y=1,cx=0,cy=0
56 89 21 77 88 66
97 44 66 10 16 87
2 60 23 56 47 3
x
y
S2
y<=Number of Vertical Pixel
S3
x<=Number of Horizontal Pixel (Two say scan)
S4
amp calculate
freq calculate
S5
Mod[x,c1]==0 or δ ==c2
no
S6
cx+= π /freq
yes
S7
cx=0
cy=rireki[x]
S8
I'[x,y]=I[x,y]+ Σ E[x,y]+amp·sin[cx+cy+ σ]
Quantize
O(x,y) calculate
S9
E[x,y] calculate
Rireki[x]-= π /freq
S10
x++
(x--)
S11
y++
end

FIG. 16



Smooth Density Variation by arranging together C, M, Y dot

FIG. 17

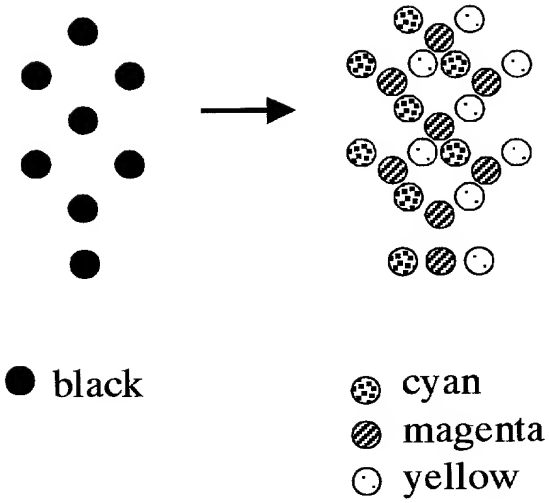


FIG. 18

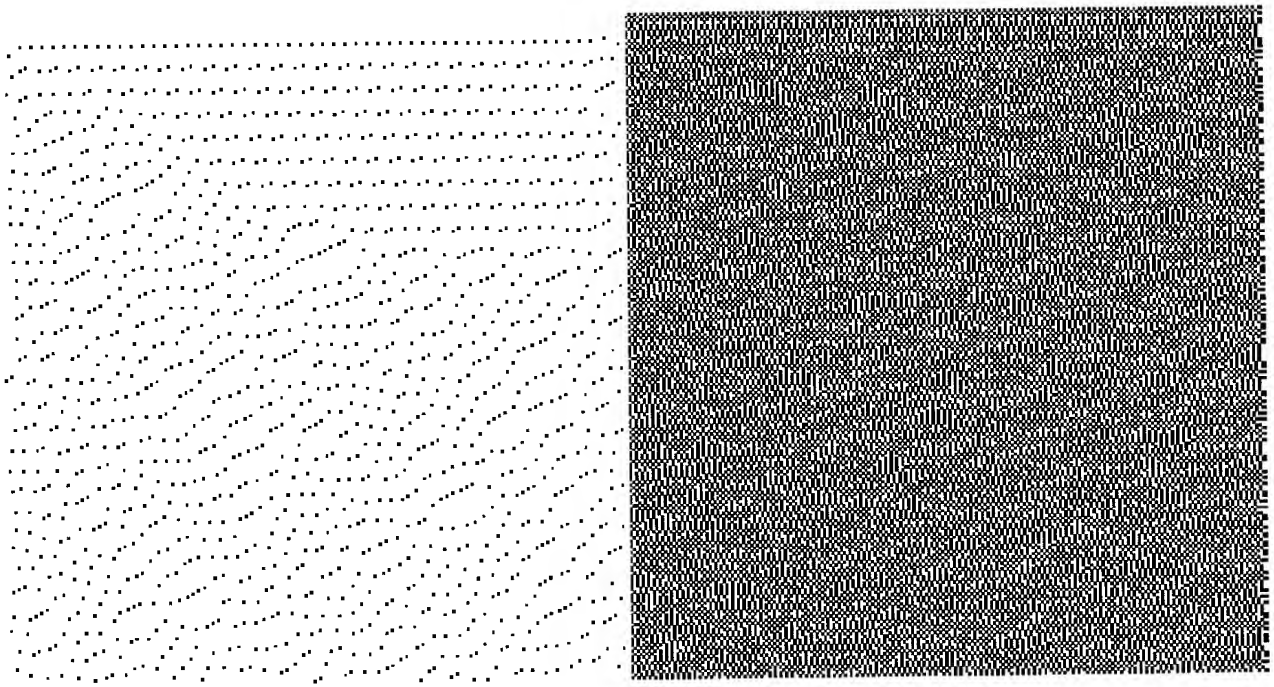


FIG. 19

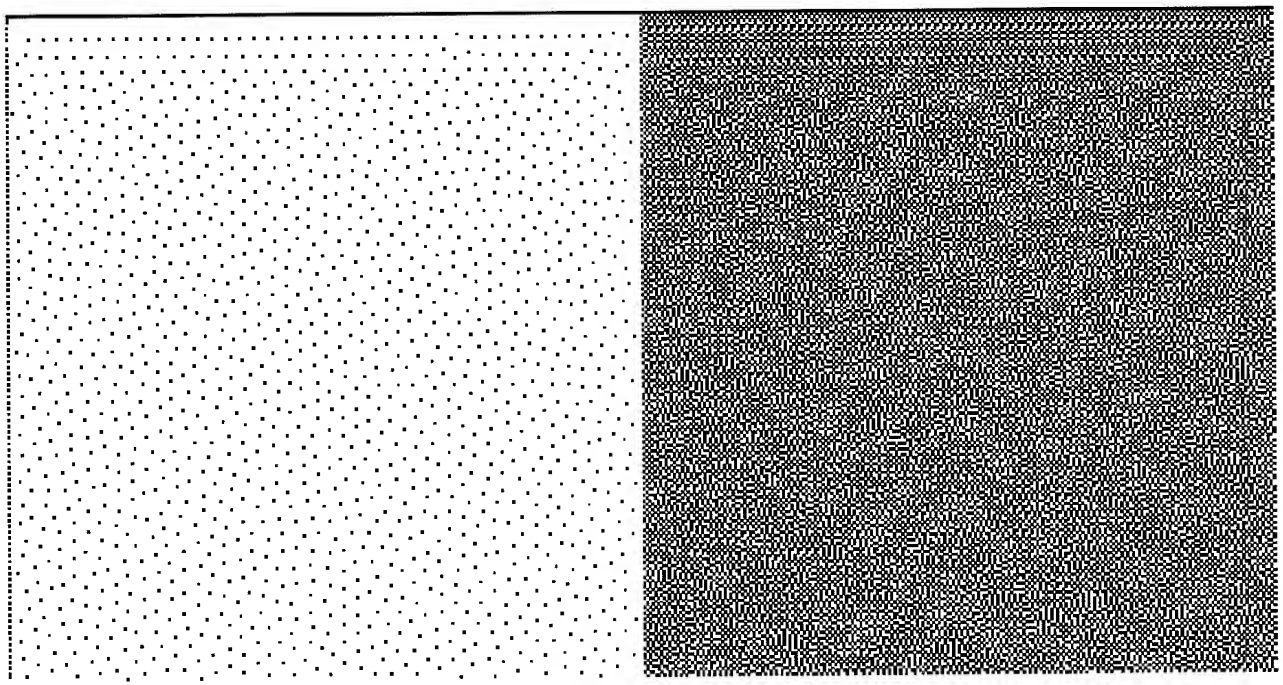
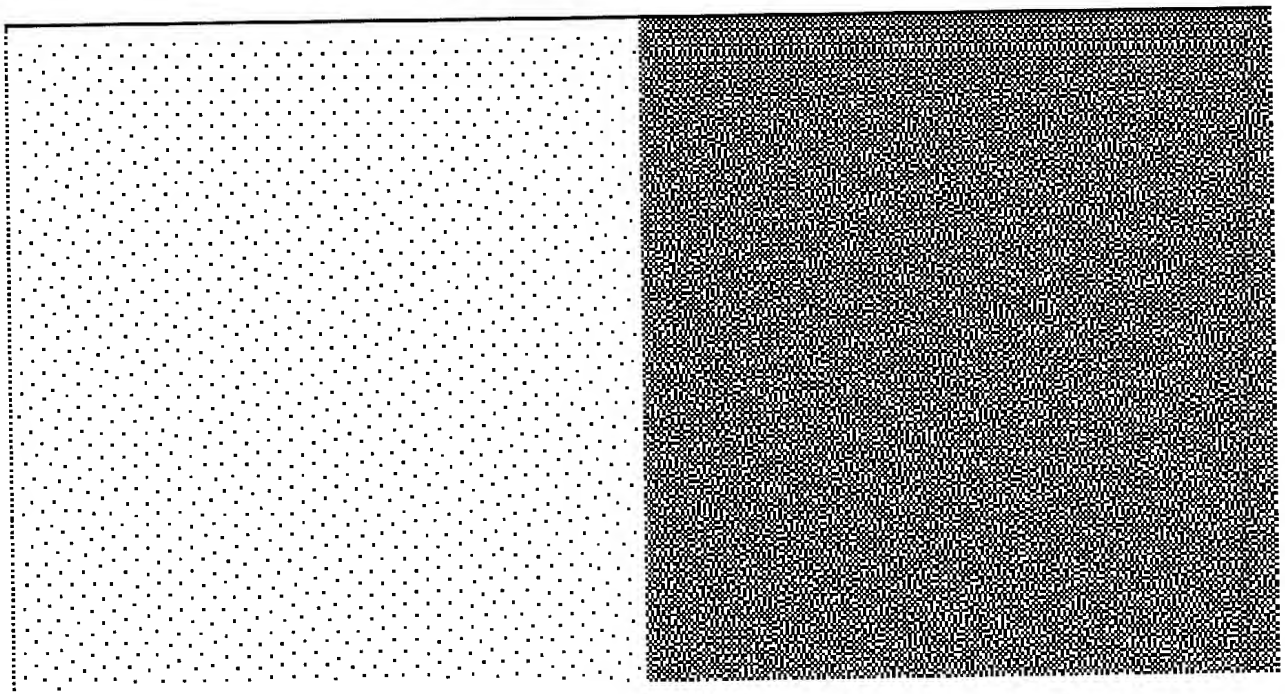



FIG. 20